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(54) Fuel injection nozzle.

(57) A fuel injection nozzle for supplying fuel to an internal combustion engine includes a valve member (17) which co-operates with a seating surface (14) in a nozzle body to prevent fuel flow through an outlet orifice (13) extending from a "sac" volume (16) downstream of the seating surface. The valve body and the valve member downstream of the seating surface define spaced parallel truncated conical surfaces which have a cone angle less than that of the seating surface. The surface defines a flow restriction gap the degree of restriction offered by the gap decreasing at a lower rate as the valve member is lifted from the seating surface, than the degree of restriction between the valve member (17) and the seating surface (14).

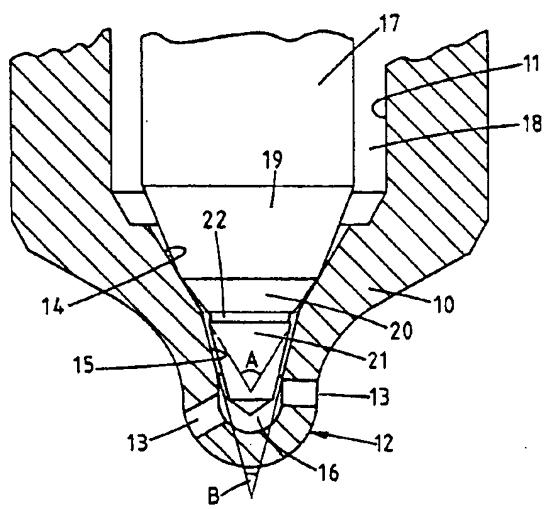

FIG. 1.

"FUEL INJECTION NOZZLE

This invention relates to a fuel injection nozzle for supplying fuel to an internal combustion engine, the nozzle being of the so-called inwardly opening type and comprising a nozzle body in which is defined a bore at one end of which is formed a truncated conical seating surface, the nozzle body defining a further surface downstream of the seating surface and which forms a "sac" volume from which extends an outlet orifice, a valve member slidable in the bore and adapted for co-operation with the seating surface to control the flow of fuel through the outlet orifice from a fuel inlet.

Such a nozzle is utilised to supply fuel to a compression ignition engine and it is desirable with such engines that the initial flow of fuel to the engine should be at a restricted rate. In fuel injection nozzles of the aforesaid kind the gap between the valve member and the seating surface during the initial movement of the valve member away from the seating surface does form a restriction to the flow of fuel. However, in a known nozzle the valve member is provided with a conical portion having a cone angle which is slightly greater than the cone angle of the seating surface. The effect is that in the closed position of the valve member line contact is established between the conical portion of the valve member and the seating surface. As the valve member lifts from the seating surface the zone of maximum restriction to the flow of fuel advances along the seating surface towards the "sac" volume. Since the cone angle is about 60° the range of movement of the valve member during which restriction to the flow of fuel is obtained is small and within that range the degree of restriction is very sensitive to the lift of the valve member. The valve member is invariably lifted from the seating surface by the action of the fuel pressure supplied by the associated fuel injection pump and since the pressure can rise very quickly, there is substantially no control of the initial rate of fuel flow. The sensitivity to valve member lift can be reduced and the aforesaid range of movement increased, by reducing the cone angle but this can lead to problems in that the valve member can become wedged into the seating surface.

The object of the present invention is to provide a nozzle of the kind specified in which the sensitivity of the restriction to the flow of fuel to the lift of the valve member is reduced and the range of movement during which restriction is obtained, is increased.

According to the invention a nozzle of the kind specified comprises a flow restriction gap downstream of the seating, said gap being defined between an extension on the valve member and the valve body, the degree of restriction offered by said gap decreasing at a lower rate as the valve member is lifted from the seating surface, than the degree of restriction between the valve member and the seating surface.

Examples of fuel injection nozzle in accordance with the invention will now be described with reference to the accompanying drawings each of which is a sectional side elevation of part of a fuel injection nozzle for supplying fuel to an internal combustion engine.

Referring to Figure 1 of the drawings the nozzle comprises a nozzle body 10 in which is formed a bore 11. The nozzle body is shaped at one end to form a nozzle tip 12 in which is formed in the example, a pair of outlet orifices 13. The bore 11 at the tip end of the nozzle defines a truncated seating surface 14 which leads into a second truncated surface 15 which in turn leads into a "sac" volume 16 from which extends the outlet orifices 13.

Located within the bore 11 is a valve member 17 the portion of the valve member seen in the drawing being of reduced diameter as compared with the bore so as to define an annular gap 18 to which fuel under pressure is supplied from a nozzle inlet, the nozzle inlet in use being connected to the outlet of a fuel injection pump. At another position in the nozzle body the valve member has a diameter corresponding to that of the bore so as to form a sliding fit therewith and the valve member defines an additional annular surface which is exposed to the pressure at the fuel inlet.

The lower end of the valve member defines three truncated conical portions 19, 20 and 21. The conical portion 19 has a cone angle which is smaller than the cone angle of the seating surface 14 whilst the portion 20 has a cone angle which in the usual manner is slightly larger than that of the seating surface 14. The cone angle of the surface 14 is indicated by the letter A. The portion 21 of the valve member and which extends into the volume 16, has a cone angle which is the same as the cone angle of the surface 15, this cone angle being indicated by the letter B. It will be noted however that the surface of the portion 21 of the valve member is parallel to and spaced from the surface 15 so as to form a clearance and to ease the machining of the valve member, an undercut 22 is provided at the junction of the portions 20 and 21 of the valve member.

In operation, when fuel under pressure is supplied to the aforesaid inlet the valve member will be lifted against the action of a spring, away from the seating surface 14. Initially the maximum restriction to the flow of fuel will be between the

seating surface 14 and the junction of the portions 19 and 20 of the valve member. However, with a further slight increase in the lift of the valve member the point of maximum restriction will transfer to the gap defined between the conical portion 21 of the valve member and the lower end of the surface 15 that is to say at the junction of the surface 15 with the wall of the volume 16. Since the cone angle of the conical portion 21 of the valve member is smaller than that of the seating surface 14 and the portion 20 of the valve member, the variation in the degree of restriction offered to the flow of fuel as the valve member lifts from its seating, will be appreciably less than in the standard nozzle where the portion 21 and the surface 15 are not provided. The rate of increase in flow of fuel for a given increase in the lift of the valve member will therefore be considerably less.

Figure 2 illustrates a modification to the nozzle shown in Figure 1 and the essential difference is that the portion 21 of the valve member of Figure 1 is replaced by a cylindrical extension 23 which extends in the closed position of the valve member to within the volume 16. It will be noted that in both examples, the valve member has a conical portion at its lower end and the conical portion 24 in Figure 2, forms a junction 25 with the cylindrical portion 23 and it is the gap between the junction 25 and the surface 15 which provides the variable restriction.

In the particular examples, the angle A is nominally 60° and the angle B is nominally 30°. However, the angle B may be reduced to say 10° in order to further reduce the sensitivity of the flow area to the lift of the valve member. It will be appreciated that the portion 21 of the valve member of Figure 1 must be sufficiently short so as to avoid restriction to the flow of fuel at the maximum lift of the valve member.

Figure 3 shows a modification of the example shown in Figure 2 in which the second truncated conical surface 15 of the example of Figure 2 is replaced by a curved control surface 26. The effect of the curved surface is the same as the truncated surface, the degree of restriction between the junction 25 and the surface 26 reducing as the valve member is moved away from the seating.

Figure 4 shows a further modification in which the seating surface 14 connects directly with the cylindrical wall of the volume 16, an annular control edge 27 being defined at the junction thereof.

The lower end of the valve member defines three truncated conical portions 19, 20, 28. The conical portion 19 has a cone angle which is slightly smaller than the cone angle of the seating surface 14 whilst the cone angle of the portion 20 has a cone angle which is slightly larger than that of the seating surface. The extension or portion 28 of the valve member extends into the volume 16 and has a cone angle which is very much smaller than that of the seating surface, in the particular example the cone angle is 10°. The surface of the portion 28 is spaced from the edge 27 and the area of the flow path thus formed varies as the valve member moves away from the seating surface. Thus the degree of restriction to the flow of fuel will gradually reduce as the valve member moves away from the seating surface. As with the previous examples the rate of decrease will be substantially as compared with a standard nozzle.

Claims

1. A fuel injection nozzle for supplying fuel to an internal combustion engine, the nozzle being of the so-called inwardly opening type and comprising a nozzle body (10) in which is defined a bore (11) at one end of which is formed a conical seating surface (14) the nozzle body defining a further surface downstream of the seating surface and which forms a "sac" volume (16), an outlet orifice (13) extending from said volume, a valve member (17) slidable in the bore and adapted for co-operation with the seating surface to control the flow of fuel through the outlet orifice from a fuel inlet characterized by a flow restriction gap downstream of the seating surface, said gap being defined between an extension (21, 23, 28) of the valve member and the valve body, the degree of restriction offered by said gap decreasing at a lower rate as the valve member is lifted from the seating surface, than the degree of restriction between the valve member (17) and the seating surface (14).

2. A nozzle according to Claim 1 characterized in that the nozzle body defines a truncated surface (15) immediately downstream of the seating surface (14), the extension (21) of the valve member defining a surface complementary to but spaced from said truncated surface (15), the cone angle of said truncated surface (15) being smaller than that of the seating surface.

3. A nozzle according to Claim 1 characterized in that the nozzle defines a truncated surface (15) immediately downstream of the seating surface (14), said extension (23) of the valve member having a cylindrical surface and extending into the "sac" volume (16), the valve member defining a junction (25) where the cylindrical surface merges into a conical end (24), said junction and said truncated surface (15) defining said gap, the cone angle of said truncated surface (15) being less than that of the seating surface.

4. A nozzle according to Claim 1 characterized in that the nozzle body defines a curved surface (26) extending between said conical seating sur-

face (14) and the further surface which defines the "sac" volume (16), said extension 23 of the valve member having a cylindrical surface and extending into the "sac" volume, the valve member defining a junction (25) where the cylindrical surface merges into a conical end (24), said junction and said curved surface defining said gap.

5. A nozzle according to Claim 1 characterized in that said seating surface (14) and the further surface define an annular control edge (27) and the extension (28) of the valve member has a truncated conical surface which forms with the edge said gap, the cone angle of the truncated conical surface of said extension being smaller than that of the seating surface.

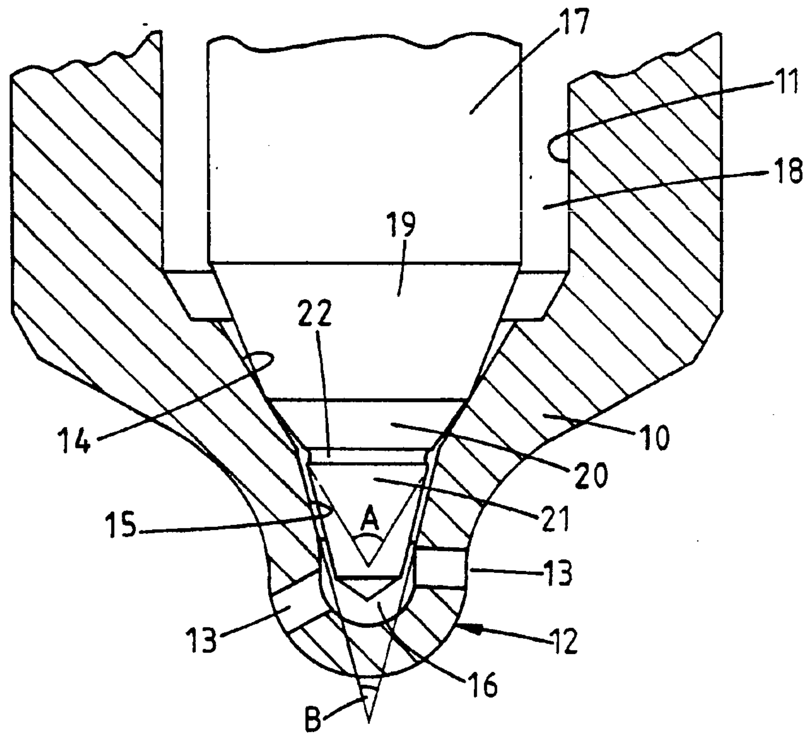
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FIG. 1.

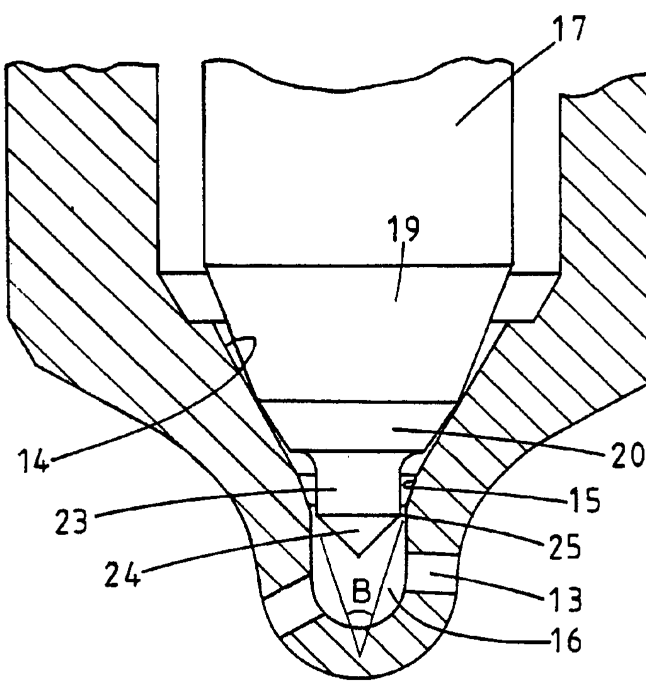
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FIG. 2.

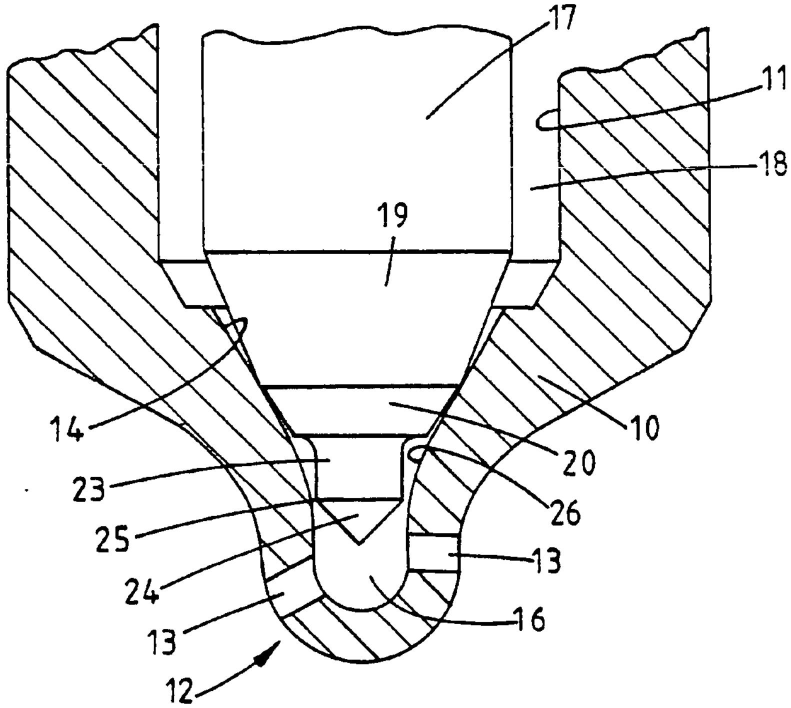
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FIG.3.

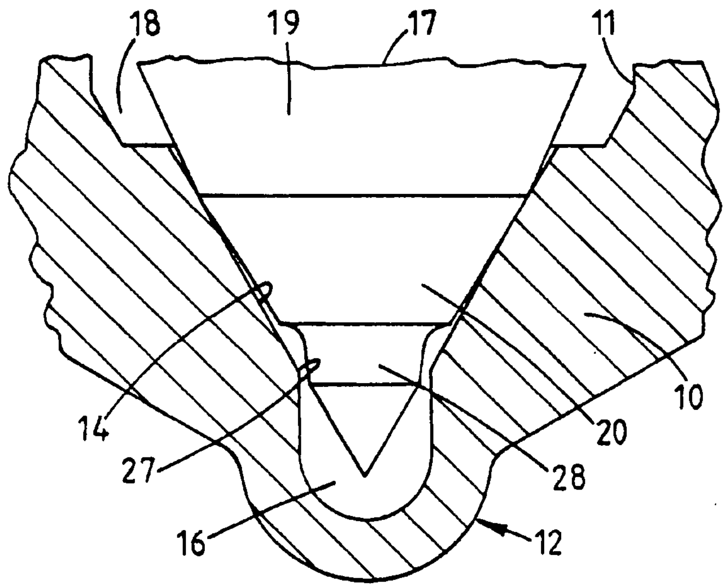
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FIG.4.

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EUROPEAN SEARCH REPORT

Application Number

EP 88 30 1692

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
Y	GB-A-2 138 073 (BOSIO) * Abstract; page 2, lines 43-102; figures 3-8 *	1-3,5	F 02 M 61/06 F 02 M 61/18
Y	GB-A-2 083 134 (NISSAN) * Page 1, lines 76-101; figures 3,5 *	1-3	
Y	US-A-4 524 914 (KAIBARA) * Column 4, line 5 - column 7, line 7; figures 2-4 *	1,5	
A	DE-C- 837 337 (KLÖCKNER-HUMBOLT-DEUTZ) * Whole document *	1,2	
A	GB-A-2 034 816 (M.A.N.) * Page 2, lines 51-79; figures 3-8 *	1	
A	FR-A-2 383 320 (BOSCH) * Page 2, line 16 - page 4, line 30; figures 1-3 *	1,2,5	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	GB-A-2 143 274 (LUCAS) * Page 1, line 67 - page 2, line 101; figures 1-5 *	1,3,4	F 02 M
A	GB-A-2 029 508 (BENDIX) * Page 3, lines 69-127; figure 3 *	1,4	
A.	DE-C- 894 789 (DAIMLER-BENZ)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21-06-1988	FRIDEN C.M.

CATEGORY OF CITED DOCUMENTS

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